SPECIFICATION

[Title of the invention]

LIQUID CRYSTAL DISPLAY DEVICE WITH REPAIR FUNCTION

[Brief description of the drawings]

Fig. 1 is a plan view showing the structure of a conventional liquid crystal display device with a high aperture ratio;

Fig. 2 is a sectional view of the liquid crystal display device taken along A-A' line in Fig. 1;

Fig. 3 is a sectional view of the liquid crystal display device taken along B-B' line in Fig. 1;

Fig. 4 is a plan view of the conventional liquid crystal display device when the data line and the gate line thereof make short;

Fig. 5 is a view for explaining a conventional method of repairing a short of the line;

Fig. 6 is a plan view showing the structure of a liquid crystal display device with a repair function according to an embodiment of the present invention;

Fig. 7 is a sectional view of the liquid crystal display device taken along C-C' line in Fig. 6;

Fig. 8 is a sectional view of the liquid crystal display device taken along D-D' line in Fig. 6;

Fig. 9 is a plan view showing the structure of a liquid crystal display device with a repair function according to another embodiment of the present invention;

Fig. 10 is a sectional view of the liquid crystal display device taken along E-E' line in Fig. 9;

Fig. 11 is a plan view showing the structure of a liquid

crystal display device with a repair function according to still another embodiment of the present invention;

Fig. 12 is a view for explaining a repairing method for the liquid crystal display device according to an embodiment of the present invention;

Fig. 13 is a plan view showing the structure of a liquid crystal display device with a repair function according to still another embodiment of the present invention; and

Fig. 14 is a view for explaining a repairing method for the liquid crystal display device according to another embodiment of the present invention.

Detailed descriptions of the reference number

2,22 : lower glass	4,24 : gate insulating film
6,26 : semiconductor layer	8,28 : data line
10,30: pixel electrode	12,32 : protective film
14,34: gate line	16,36 : source electrode
18,38: drain electrode	
40 : cutting line	
42 : storage electrode	

[Detailed description of the invention]

[Object of the invention]

[Technical field including the invention and prior art therein]

This invention relates to a liquid crystal display device, and more particularly to a liquid crystal display device with a repair function that is capable of repairing defects caused by the breaking or short of circuits.

Generally, a liquid crystal display(LCD) is a tendency to have a gradually widen application range owing to its characteristics such as the light weight, the slim

type and the low power driving, etc. Accordingly, the LCD has been used for an office automation equipment and a video/audio equipment, etc.

Referring to Fig. 1, the conventional LCD includes a source electrode 16 branched from a data line 8 to apply an image signal, a gate electrode 20 branched from a gate line 14 to apply a scanning signal, and a drain electrode 18 for applying a data signal to a pixel electrode 10. A number of data lines 8 are provided in a vertical direction at a lower glass 2 to transmit a data signal applied from a data driver(not shown) to each source electrode 16. A number of gate lines 14 are provided in a horizontal direction at the lower glass 2 in such a manner to be crossed with each data line 8 to transmit a scanning signal applied from a gate driver(not shown) to each gate electrode 16. At this time, a scanning signal transmitted from the gate line 14 is applied to the gate electrode 16 to turn on a thin film transistor, thereby transmitting a data signal applied to the gate electrode 16 to the drain electrode 18. In other words, the gate electrode 16 switches the data signal in correspondence with the scanning signal. A data signal transmitted to the drain electrode in this manner is applied to the pixel electrode 10, and an orientation of the liquid crystal is changed in such manner to correspond with a level of a data signal applied between the pixel electrode 10 and the common voltage layer(not shown), thereby controlling a transmission amount of a light beam.

In this case, since the pixel electrode 10 is a region at which a light beam is really transmitted, the larger the pixel electrode area, the higher the aperture ratio.

Accordingly, as shown in Fig. 1, the pixel electrode 10 is overlapped with the gate line 14 and the data line 8 so as to implement a liquid crystal display device with a high aperture ratio. To this end, an organic protective film with a relatively low dielectric constant of about 2.7 such as benzocyclobutene(BCB) is used. In this case, since a dielectric constant of the organic protective film is low, it becomes possible to overlap the pixel electrode with the data line. A liquid crystal display device with a high aperture ratio can be implemented by overlapping the pixel electrode with the data electrode in this manner.

A structure of the data line 8 taken along A-A' line in Fig. 1 will be described in conjunction with Fig. 2. As shown in Fig. 2, a gate insulator(GI) 4 is formed on the upper portion of the lower glass 2. At the upper portion of the GI 4, a semiconductor layer 6 provided optionally and the data line 8 are sequentially provided. A protective film 12 is coated on the data line 8. The pixel electrode 10 is provided at the upper portion of the protective film 12 in such a manner to be overlapped with the data line 8 in a desired distance.

Further, a structure of the gate line 14 taken along B-B' line in Fig. 1 will be described in conjunction with Fig. 3. As shown in Fig. 3, the gate electrode 14 is formed selectively at the upper portion of the lower glass 2. The GI 4 is entirely coated on the gate electrode 14. The protective film 12 is coated on the GI 4. The pixel electrode 10 is provided at the upper portion of the protective film 12 in such a manner to be overlapped with the gate line 14. In order to implement a liquid crystal

display device with a high aperture ratio, the gate line 14 and the pixel electrode 10, or the data line 8 and the pixel electrode 10 are arranged in the structure overlapped in a desired distance with respect to each other.

In the liquid crystal display device with a high aperture ratio, a distance between the pixel electrodes is narrow to generate a short between the adjacent pixel electrodes. Upon generation of the short, a point defect occurs at the corresponding pixels. For instance, if the (n,n) numbered pixel electrode and the (n+1,n) numbered pixel electrode at the data line 8 is cut along a cutting line 9 so as to cut any one of these pixel electrodes when they make short, then the pixel electrode having each terminal overlapped with the gate line 14 must be cut. In this case, a short circuit is generated between the gate line 14 and the pixel electrode 10. On the other hand, the similar process is performed when the (n,n) numbered pixel electrode and the (n+1,n) numbered pixel electrode at the gate line 14 make short, so that a short circuit is generated between the data line 8 and the pixel electrode 10. The conventional liquid crystal display device with a high aperture ratio has a problem in that a repair is impossible upon such a short generation between the adjacent pixel electrodes.

Fig. 4 is a plan view of the conventional liquid crystal display device when the data line and the gate line thereof make open. As shown in Fig. 4, an open circuit is generated at the gate line 14 or the data line 8. For instance, in order to repair an open circuit in the data line 8, the first point P1 and the second point P2 with a separate pattern (or a repairing line) are welded as shown in Fig. 5

to reform an electric path of the open-circuited data line 8. On the other hand, at the time of open circuit of the gate line 14, an electric path of the open-circuited gate line 14 is reformed in the similar manner. As described above, the conventional liquid crystal display device requires a separate pattern or line so as to repair the open-circuited line. As a result, there has been requested a new scheme for appropriately repairing an open circuit and a short circuit generated frequently at the liquid crystal display device with a high aperture ratio.

These and other objects of the invention will be apparent from the following detailed description of the embodiments of the present invention with reference to the accompanying drawings.

Referring to Fig. 6, there is shown a liquid crystal display device with a repair function according to an embodiment of the present invention that includes a pixel electrode formed in such a manner to be spaced with a gate line 34 and a data line 8. As shown in Fig. 7, in the liquid crystal display device with a repair function, the gate line 34 is formed on an insulating substrate 22 and a gate electrode is integral to the gate line 34. A GI 24 is provided at the upper portion of the gate line 34. At the upper portion of the GI 24, the data line 8 and a semiconductor layer 6 are formed in such a manner to be crossed with the gate line. At this time, a source electrode 36 integral to the data line 8 and a drain electrode 38 spaced oppositely with the source electrode 36. Subsequently, a protective film 32 having a desired thickness is provided. At this time, a first contact hole 37 is defined at a position corresponding to a drain electrode part 38 at the protective film 32. The first

contact hole 37 connects the pixel electrode 30 and the drain electrode part 38 electrically.

Meanwhile, an organic protective film is used as the protective film 32 as indicated in the following table:

Table 1

Type and Dielectric constant of the organic protective film

Type of Organic Protective Film	Dielectric Constant
Polymide added with Fluoropolyarylether	2.7
Teflon	1.9-2.1
Cytop	2.1
BCB(BenzoCycloButene)	2.7
Fluoropolyarylether	2.6
Para-Xylene added with Fluoropolyarylether	2.4

A storage electrode 42' overlapped with the gate line 34 by a pixel extension part extending from the pixel electrode 30 is formed of a material identical to the pixel electrode 30. At this time, the corner of the storage electrode 42' is spaced from the data line 28 by a desired width δ for the sake of permitting a repair. An aperture ratio may be improved by providing a gate line overlapping part 33 in which the post stage gate line is overlapped with the pixel extending part as needed. The gate line overlapping part 33 and the storage electrode 42' are spaced by a desired length α from the data line. The desired length α means a length permitting a repair of the pixel electrode 30. At this time, it is desirable that the length α and the width

δ spaced from the pixel electrode 30 is set to correspond with a resolution of the laser. For instance, a resolution of the laser used for a repair work largely is about 5μm.

Fig. 8 is a sectional view showing other side corners of the data line 28. As shown in Fig. 8, the GI 24 and the protective film 32 are formed at the upper portion of the lower glass 22. In this case, an organic protective film as indicated in Table 1 is used as the protective film 32. The pixel electrode 30 is provided at the upper portion of the protective film 32. The pixel electrode 30 and the data line 28 is spaced by a desired width δ. The desired width δ means a distance permitting a repair of the pixel electrode 30.

A method of repairing the (n,n) numbered pixel electrode and the (n+1,n) pixel electrode in Fig. 6 when they make short will be described. To this end, any one of the two pixel electrodes is cut with the laser. For instance, the (n,n) numbered pixel electrode is cut along a cutting line 40 with the laser. Thus, the short-circuited (n,n) and (n+1,n) numbered pixel electrodes are electrically isolated from each other. Accordingly, point defects of the short-circuited pixel electrodes 30 can be removed. Also, a repair can be performed by the similar method when the (n,n) numbered pixel electrode and the (n,n+1) numbered pixel electrode make short.

Referring now to Fig. 9, a liquid crystal display device with a repair function according to another embodiment of the present invention includes a pixel electrode 30 spaced from a gate line 34. The upper and lower portions of the

pixel electrode 30 are spaced by a desired length α from the gate line 34 for the sake of permitting a repair. A storage electrode 42 overlapped with the gate line 34 by a pixel extension part extending from the pixel electrode 30 is formed of a material identical to the pixel electrode 30. The storage electrode 42 is spaced from the data line 28 by a desired width δ from the data line. At this time, it is desirable that the length α and the width δ spaced from the pixel electrode 30 is set to correspond with a resolution of the laser. For instance, a resolution of the laser used for a repair work largely is about 5μm. The storage electrode 42 and the pixel electrode 30 is electrically connected via a second contact hole 39. As shown in Fig. 10, the gate electrode 34 is formed at the upper portion of the lower glass 34. The storage electrode 42 overlapped with the gate electrode 34 is electrically connected to the (n,n+1) numbered pixel electrode by the second contact hole 39. In this case, the (n,n) numbered pixel electrode is spaced by a desired distance from the gate line 34.

An aperture ratio decreases by about 1% in comparison to the liquid crystal display device shown in Fig. 6 by spacing the upper and lower portions of the pixel electrode 30 from the gate line 34 by a desired length α, but a point defect in the pixel electrode connected vertically becomes almost "0" because a distance between the (n,n) numbered pixel electrode and the (n,n+1) numbered pixel electrode is sufficiently assured.

Meanwhile, when the (n,n) numbered pixel electrode and the (n+1,n) pixel electrode in Fig. 9 make short, any one of

the two pixel electrodes is cut with the laser so as to repair them. For instance, the (n,n) numbered pixel electrode is cut along a cutting line 40 with the laser. Thus, the short-circuited (n,n) and (n+1,n) numbered pixel electrodes are electrically isolated from each other. Accordingly, point defects of the short-circuited pixel electrodes 30 can be removed.

Referring to Fig. 11, a liquid crystal display device with a repair function according to still another embodiment of the present invention includes a pixel electrode 30 spaced from a gate line 34. The upper and lower portions of the pixel electrode 30 are spaced by a desired length α from the gate line 34 for the sake of permitting a repair. At this time, the pixel electrode 30 is overlapped with a data line 28. In this case, a storage electrode 42 is formed in such a manner to be overlapped with a portion of the gate line 34. The storage electrode 42 and the pixel electrode 30 are electrically connected via a contact hole.

On the other hand, a method of repairing the data line 28 in Fig. 11 when it makes open will be described in conjunction with Fig. 12. As shown in Fig. 12, one side point P3 at which one side of open-circuited data line 28 is overlapped with the pixel electrode 30 and the other side point P4 at which other side of open-circuited data line 28 is overlapped with the pixel electrode 30 are welded with a laser. Subsequently, the open points P3 and P4 in the open-circuited data line are electrically connected by cutting the pixel electrode along a cutting line 42 so that the data line can be repaired.

Referring to Fig. 13, a liquid crystal display device with a repair function according to still another embodiment of the present invention includes a pixel electrode 30 spaced from a gate line 34 and a data line 28. The four corners of the pixel electrode 30 are spaced by a desired length α from the gate line 34 while being space by a desired width δ from the data line 28 for the sake of permitting a repair. The gate electrode 34, the data line 28 and the pixel electrode 30 are overlapped with each other except for the four corners of the pixel electrode 30.

On the other hand, a method of repairing the data line 28 and the gate line in Fig. 13 when they make open will be described in conjunction with Fig. 14. As shown in Fig. 14, one side point P3 at which one side of open-circuited data line 28 is overlapped with the pixel electrode 30 and the other side point P4 at which other side of open-circuited data line 28 is overlapped with the pixel electrode 30 are welded with a laser. Subsequently, the open points P3 and P4 in the open-circuited data line are electrically connected by cutting the pixel electrode along a cutting line 40, so that the data line can be repaired. In the similar manner, the data line can be repaired by connecting two points P4 and P5 at the open-circuited gate line 34 electrically using the pixel electrode 30.

[Effect of the invention]

As described above, the liquid crystal display device with a repair function according to the present invention has an advantage in that a process yield can be improved by arranging the pixel electrode in correspondence with a

short circuit or open circuit of the electrode for the sake of permitting a repair thereof.

Although the present invention has been explained by the embodiments shown in the drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents.